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ABSTRACT

This document describes how 10 mathematics and numeracy teachers from Technical and Further Education colleges and community providers in Australia assisted in identification of mathematics skills that would form the mathematics component of the Adult Basic Education Curriculum Framework. The draft competencies are organized under the headings of measurement, space, number, data, and algebra. The four-page narrative of the development of the draft mathematics competencies is followed by the draft competencies themselves, arranged according to strands: measurement, space, number, data, and algebra. Competencies are grouped within each strand by level. A listing of the draft competencies arranged according to levels is then provided. Within each level, the competencies are grouped by strand. (YLB)

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ADULT BASIC EDUCATION ACCREDITATION FRAMEWORK PROJECT

VOLUME THREE

DRAFT COMPETENCE STATEMENTS FOR ADULT MATHEMATICS

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Ruth Goddard	CAE Background

BACKGROUND

At the first Adult Basic Education Curriculum Consultative Conference about ten mathematics and numeracy teachers from TAFE colleges and community providers met with the project officer to discuss the format and contents of the mathematics component of the Adult Basic Education Curriculum Framework.

Alternative forms of organisation which would highlight all the aspects considered most important in the design of any mathematics curriculum were discussed at length. This was considered a **first step** in deciding upon the final competencies. In particular the aspects of:

- confidence building;
- language;
- use and application of mathematics in meaningful contexts; and
- logical reasoning and problem solving;

were highlighted as needing to be given as much emphasis as the learning and practice of standard skills. It was also agreed that mathematical skills should encompass more that the traditional number skills; measurement, space and shape, graphical interpretation, and presentation of data should be given high priority at all levels.

At the meeting many of the particular skills thought of as most important were brainstormed and placed into levels. This enabled an intuitive 'feel' for the four levels to emerge and provided the beginnings of a description of these levels in relation to programs currently being run. Initial constraints being that level 1 should assume no prior level of competency and that those with level 4 competencies would be ready to begin VCE or other training or have sufficient skills to satisfy employers requiring year 10 level maths.

Levels 1 and 2 were seen as skills associated with two stages of Numeracy; of maths for everyday use, whether taught in separate numeracy classes or integrated within literacy classes. **Level 1** concentrates on the personal, domestic and familiar.

Level 2 reaches into more impersonal contexts; the skills and knowledge needed for moving in the public arena and the world of work. It focuses on language and skills needed for communication with other people, understanding instructions, interpreting numerical information found in the media, and dealing with monetary transactions.

Level 3 was seen as mathematics beyond the 'everyday use'; the acquisition of early stages of knowledge and methodologies which represent the fundamental building blocks of mathematics. Teachers assisting students at this level would need to be suitable, experienced mathematics teachers.

Level 4 describes mathematics similar in nature to level 3, but with greater complexity and using more of the body of mathematical knowledge. It requires increased ability to make independent choices of the techniques appropriate to particular problem solving situations.

It was agreed that students may be operating at many of these levels within the same classroom, but in general levels 1 and 2 would be happening in numeracy classes whilst levels 3 and 4 were usually addressed in programs using various titles such as basic or bridging mathematics.

These agreed descriptions provided a starting point for an initial framework which was built upon in subsequent meetings and discussions. It evolved in a fairly simplified format as shown:

	Measurement	Space	Number	Data	Algebra
Level 4					
Level 3					
Level 2					
Level 1					----

About the Competencies

The competencies are presented under organising headings of measurement, space, number, data, algebra, to ensure important aspects of mathematical ability are not overlooked. It is not however, intended that these strands be taught as isolated lists of topics. In fact they are to be seen as interrelated and overlapping, and the skills and knowledge behind them should be taught, where possible, in an integrated way. For example, number skills should not be seen as isolated processes but skills used in order to operate on sums of money, on data, and for measurement and related calculations, thus bringing together three strands in the early levels. Algebraic skills should be developed in conjunction with data, measurement, and sometimes space, and their development relies heavily on previously developed number competencies, and building knowledge and skills in the space strand obviously requires the skills developed in the area of measurement.

For each cell a draft content was created which paid attention to all the aspects thought to be important: language; concepts and knowledge; skills; possible practical, political and social applications; and associated language. From these documents a set of draft competencies has evolved which hopefully encapsulate all the features considered most important at each level and in each area of mathematics.

One issue which emerged during this work was the question of what does "readiness to enter VCE mathematics" mean? Given the diversity of possible VCE mathematics subjects currently available, possible changes to these in the near future, and the fact that only Units 3 and 4 VCE mathematics subjects count towards an Adult VCE, this was a complex and important question to be dealt with.

The final decision was that the core mathematics competencies, those in the columns above, were needed for the VCE purposes of the majority of students and were certainly suitable for students entering forms of training other than VCE. These competencies were seen by VCAB personnel as definitely sufficient to enter any Unit 1/2 VCE

mathematics subjects and they would also lead to successful participation in the VCE Mathematics Units 3/4 Space and Number.

It was decided that it was also necessary to provide a pathway for students wishing to proceed with more specialist maths/science based courses. For them, an optional column will be added to the core, so that the structure will expand as shown:

	Measure-ment	Space	Number	Data	Algebra	**Specialist Maths**
Level 4						
Level 3						
Level 2						
Level 1						

The final column is purely optional for students with specific needs or specialist interests, it will not be seen as necessary for the award of any basic certificate.

Calculator Use

Although calculators are mentioned specifically only in the number strand, it is assumed they will be regarded as a tool to be used in all aspects of mathematics at all levels; for example for evaluating formulae in algebra and measurement; for calculating averages in data; and for working out scales in the space strand.

The use of a calculator for all aspects of calculation should be seen as an important set of competencies in itself and given as much emphasis as the ability to perform arithmetical operations manually. It might even be argued that accurate use of a calculator is a skill valued more highly by modern employers than other form of arithmetic, it is certainly vital for potential students of further mathematics.

Computer Use

Another valuable tool for students of mathematics is the computer and many commonly available software packages. Their use has not been built into the competencies because they are not yet available to all adult classes, however if classes do have access to computers their importance should not be overlooked. Spreadsheets are a wonderful means of illustrating the power of algebra, especially in the realms of finance, looking at loan repayments and the like, and are valuable assets in data analysis. Graphing packages are also an important tool in the teaching and understanding of the algebra of functions, and CAD (Computer Aided Drafting) packages or Logo packages are an exciting asset for drawing plans and geometric figures in the space strand.

Other significant influences shaping this work were:

- Discussions with literacy and numeracy teachers and tutors across Victoria during 1990-91 about the skills and knowledge used by adults pursuing everyday domestic and work lives.

- National discussions with adult numeracy personnel regarding the definitions of numeracy (as yet no definition had been agreed upon).

- The Project Officer's work during 1991 on the External Review Panel looking at the structure of VCE Mathematics.

- The definition of mathematics included in the document **ALBE into the 1990's**, Bradshaw et al.

  > *The term "mathematics" in a generic sense relates to numerical and spatial abilities including the use of calculators, estimation, appreciation of shapes, size, direction and measurement; problem solving and logical reasoning; and the interpretation and language of mathematical data and information.*

The **National Statement on Mathematics for Australian Schools** (1991) was used as a reference point although those statements used needed considerable adaptation and careful selection when applying them to the needs of adult students.

The Next Step

During 1992 these **draft** competency statements will be disseminated to practising teachers and tutors in the Adult Basic Education field.

It is planned that, through consultation and professional development activities, these practitioners will provide feedback on the accuracy of the levels, their scope, and what is being expected of students in terms of these statements. In addition, the usefulness of these statements as a guide to curriculum development for the range of student needs, will be explored.

The competency statements for the specialist maths strand will also be developed as a second stage of the project concurrently with the above process.
The feedback gained should enable a final writing of the competency statements and development of illustrative examples to assist providers planning mathematics curricula.

DRAFT COMPETENCIES ARRANGED ACCORDING TO STRANDS

MEASUREMENT

LEVEL 1

Can estimate:

- properties such as height, length, weight and capacity of familiar objects;
- time; and
- temperature;

to an extent sufficiently realistic to demonstrate understanding of the concept and the unit.

Can then select an appropriate measuring instrument to measure the property using common units such as, centimetres, metres, litres, kilograms, degrees, hours and minutes to a level of accuracy sufficient for domestic purposes.

Can use the language of comparison such as shorter, wider, heavier, hottest to compare such properties.

LEVEL 2

Can read and interpret the detailed calibrations such as mm, ml, gms on a range of measuring instruments especially those relevant to work situations

Can apply prefixes such as centi, milli, kilo to the base units of measurement such as metre, litre to the base in such a way as to show understandings of their meaning.

Can perform calculations involving:

- conversions within the metric system such as metres to mm, litres to ml (not necessarily in decimal form);
- standard arithmetic operations in order to compare sizes, measured in different units and to calculate quantities for purchasing, supplying, filling or catering.

LEVEL 3

Can use a protractor to measure and construct angles.

Can demonstrate an understanding of the concepts and appropriate units of :

- area by estimation and counting squares;
- simple rates such as speed and density by calculations based on empirical measurements;
- perimeter and circumference by estimation and measurement.

Can demonstrate an understanding of the formulae for area of a rectangle, and volume of a cuboid by using diagrams or by modelling with square tiles, cubes, MAB blocks, etc.

Can calculate areas of rectangles, volumes of cubes and cuboids, circumference of a circle using appropriate formulae

Can, when given appropriate formula, calculate possible solutions and check their reality against the original situation estimation and visualisation.

LEVEL 4

Can use the appropriate formula to find surface area and volume of:

- cubes and cuboids;
- regular prisms and cylinders;
- spheres; and
- complex figures which are a combination of any of these.

Can, when given a real world problem involving the aspects of the above, analyse the problem, model the situation by sketching diagrams, select appropriate formulae, calculate possible solutions, and evaluate the feasibility of those solutions by referring back to the original situation.

Can demonstrate an understanding of accuracy and errors in measurement by calculating upper and lower bound solutions to the above problems.

Can use the property of right angled triangles known as Pythagoras' Theorem in order to calculate lengths in problem solving situations described in words.

SPACE

LEVEL 1

Can roughly model, draw or represent specifically named, common two and three dimensional figures such as squares, triangles, circles, rectangles, cubes, sphere (balls) etc.

Can classify, describe and compare figures using everyday language of shape size, colour and other commonly used attributes.

Can give and follow directions using the everyday language of position such as over, behind, left, up, etc.

LEVEL 2

Can follow instructions involving words and diagrams to create a three dimensional object from a flat plan or pre-cut net. This could include a 3D geometric shape in paper or metal, an origami figure or a piece of pre-fabricated office equipment or stationery.

Can name or describe three dimensional objects in terms of basic shapes and attributes such as flat, curved, cubic or triangular.

Can give or follow directions to get from one location to another using the language of direction and angles including North, South, East, West, 1/2 turn, 1/4 turn, 180 degree turns, 90 degree turns:

- within a yard, room or building; and
- from one suburb to another making use of a street directory.

LEVEL 3

Can use a set square to draw right angles, parallel and perpendicular lines.

Can demonstrate an understanding of the properties and relationships between angles and intersecting and parallel lines, triangles (including Pythagoras), quadrilaterals and circles by:

- demonstration ;
- explaining by example; or
- using the relationships in mathematical problem solving situations

Can produce, interpret and compare simple scale drawings and maps with scales such as 1 cm = 1 m.

Can interpret and use the conventions of plans and drawings, including 2D representations of 3D objects.

LEVEL 4

Can demonstrate an understanding of the trigonometric ratios, sine, cosine and tangent for a given angle in a right angle triangle:

- by calculating the ratio after measurement of an accurately constructed triangle; and
- using the ratios found accurately on a calculator in problem solving situations to find unknown lengths.

Can produce and interpret scale drawings and maps with complex scales, and use them to estimate sizes and distances in the real situations.

Can use at least one angle measuring instrument such as a direction finding compass, or clinometer in conjunction with tape measures or trundle wheels to make an accurate scale drawing of a real outdoor situation involving lengths and angles, and use the drawing to determine lengths and angles not previously measured.

Can use compass and ruler to construct some simple figures such as triangles to given measurements, or perpendicularly bisected lines or angles.

NUMBER

LEVEL 1

Can count any group of objects and describe any number up to 1000 in words and symbols.

Can compare any two whole numbers up to 1000 using the language of ordering or comparison such as first, second, biggest, smaller, between.

Can recognise or create a common fraction such as a half, third or a quarter of a whole object such as a cake, an apple in familiar and practical situations.

Can identify the correct operation from addition, subtraction, multiplication, or division (as sharing) to use in a practical situation involving money, measurement or numbers of objects such as giving change, sharing, combining.

Can demonstrate understanding of the operation as above in a practical situation by acting out, or modelling the calculation using real objects, or money.

Can perform any of the above calculations on a calculator.

LEVEL 2

Demonstrate knowledge and understanding of place value in whole and decimal numbers by:

- comparing data and measurements;
- devising and using "in the head" methods for addition , subtraction and multiplication especially for quick money calculations.

Can recall addition and multiplication facts for single digit numbers in order to:

- perform standard calculations and rounded estimations for addition, subtraction, multiplication on whole numbers (particularly in the context of money and measurement);
- perform standard division operations when dividing by a single digit number and rounded estimation techniques for "long" division.

Can use a calculator for the above.

Can recognise the arithmetic in a relevant real world problem to which arithmetical operations apply, and find possible solutions using combinations of the above and check for feasibility of the solutions by referring back to the initial problem.

LEVEL 3

Can:
- use the standard operations +, - x and - on numbers including fractions, decimals and percentages;
- perform these calculations with a calculator;
- estimate possible solutions to above calculations using rounding, approximation, and the idea of upper and lower bounds.

Can recognise the arithmetic in a relevant real world problem to which standard arithmetical operations apply, find a number of possible solutions using combinations of the above, check for the reasonableness of these solutions against initial estimations, and interpret the feasibility of the solutions by referring back to the initial problem.

Can use the concepts and language associated with ratio:
- to interpret and compare statements such as one in ten, a ratio of one to ten, 10% of the population, or statements of probability and odds used in gambling;
- to interpret and describe scales for diagrams, models or graphs.

Can interpret and perform calculations using standard formulae expressed in index notation with whole number indices, such as those for areas and volume, of financial calculations, with or without a calculator.

LEVEL 4

Can:
- read and interpret very large and very small numbers when expressed in scientific notation, or as a calculator readout;
- use the laws of directed numbers to +, -, x and ÷, positive and negative numbers; and
- use the index laws for multiplication and division to perform calculations when numbers are expressed in scientific form, particularly when calculating approximate solutions for real world problems involving very large numbers.

Can recognise the arithmetic in a relevant real world problem to which large number calculation techniques apply, such as those involving populations, production/consumption of energy or food, probability of winning lotteries and other social issues; find a number of possible solutions using combinations of the above, check for the reasonableness of these solutions against initial estimations, and interpret the feasibility of the solutions by referring back to the initial problem.

DATA

LEVEL 1

Can interpret simple two column table of numbers or data.

Can collect and record simple data in the form of a table such as numbers of children, numbers of TV's and use it to create simple bar graphs and pictograms using direct scales ie. one person equals one unit.

Can interpret and analyse simple pie charts, bar graphs, pictograms and tables of the kind found on household bills, in comparative terms such as most, least, more than or less than.

LEVEL 2

Can interpret complex tables and lists such as timetables, dosage charts, repayment tables or indexes

Can collect and record statistical data in the form of a table. Use this data to plot statistical graphs including bar and line graphs using scales which count in 1's, 2's, 5's and 10's and appropriately marked axes.

Can analyse and interpret statistical graphs and tables relevant to political and social issues and use them to identify trends and make predictions

Can determine the three different types of average: mean, median and mode for a collection of single values such as age or height of the group (using a calculator where appropriate) and interpret the use of the word "average" in a range of social and political contexts.

LEVEL 3

Can represent data in the form of a pie chart, after calculating percentages and angles. This data can either be collected first hand or found from other sources such as banks or the media.

Can represent statistical information, relevant to political, social and financial issues, in the form of line graph or histogram, having determined appropriate scales and axes (more complex than counting in 1's, 2's, 5's and 10's).

LEVEL 4

Can collect and record statistical data in the form of a frequency table that requires grouping into class intervals. Use this data to plot appropriate statistical graphs including cumulative frequency curves and histograms, using standard graphing conventions to place axes, indicate scales and location of origin.

Can analyse and interpret statistical information, graphs and tables relevant to political and social issues using determined measures such as mode, median and percentiles.

ALGEBRA

LEVEL 2

Can use oral or written expressions to describe and summarise spatial and numerical patterns

Can find the unknown quantity in a worded problem ('problem solving' situation) involving one step arithmetic operations using informal methods.

LEVEL 3

Can analyse, make a generalisation verbally and write an algebraic rule or formula to express this generalisation for:

- number patterns involving one or two arithmetic steps;
- real life situations which require repeated calculations such as working out costing, or conversions from one unit to another.

Can substitute particular values into algebraic rules or formulae as above, perform the resulting calculations, and interpret the results in the original context.

Can solve equations relating to an unknown quantity using a range of techniques, including: guess, check and improve; same thing to both sides; or backtracking. (Equations should include only one or two arithmetic steps at this level.)

Can show an understanding of graphs by:

- analysing those which model the relationship between real phenomena, such as travel graphs, and interpret them either orally or in writing;
- sketching rough graphs from a relationship described in words.

Can create tables and plot graphs relating two variables, given experimental results or data, and use the graphs to predict outcomes using interpolation and extrapolation.

LEVEL 4

Can recognise the potential for algebraic methods in problem solving situations which involve unknown quantities, and can formulate an algebraic equation to express the situation using standard algebraic conventions.

Can solve equations as above using a range of techniques including: guess, check and improve; same thing to both sides, backtracking and creating a graph; and interpret the solutions in the original context.

Can analyse, make a generalisation verbally and express this generalisation algebraically or graphically for:

- non-linear number patterns; and
- real or simulated situations such as exponential growth or decay, and direct or inverse variation.

Can obtain particular values from the algebraic rules, formulae or graphs as above, perform the resulting calculations, and interpret the results in the original context.

DRAFT COMPETENCIES ARRANGED ACCORDING TO LEVELS

LEVEL 1

MEASUREMENT

Can estimate:
- properties such as height, length, weight and capacity of familiar objects;
- time; and
- temperature;

to an extent sufficiently realistic to demonstrate understanding of the concept and the unit.

Can then select an appropriate measuring instrument to measure the property using common units such as, centimetres, metres, litres, kilograms, degrees, hours and minutes to a level of accuracy sufficient for domestic purposes.

Can use the language of comparison such as shorter, wider, heavier, hottest to compare such properties.

SPACE

Can roughly model, draw or represent specifically named, common two and three dimensional figures such as squares, triangles, circles, rectangles, cubes, sphere (balls) etc.

Can classify, describe and compare figures using everyday language of shape size, colour and other commonly used attributes.

Can give and follow directions using the everyday language of position such as over, behind, left, up, etc.

NUMBER

Can count any group of objects and describe any number up to 1000 in words and symbols.

Can compare any two whole numbers up to 1000 using the language of ordering or comparison such as first, second, biggest, smaller, between.

Can recognise or create a common fraction such as a half, third or a quarter of a whole object such as a cake, an apple in familiar and practical situations.

Can identify the correct operation from addition, subtraction, multiplication, or division (as sharing) to use in a practical situation involving money, measurement, or numbers of objects, such as giving change, sharing, combining.

Can demonstrate understanding of the operation as above in a practical situation by acting out, or modelling the calculation using real objects, or money.

Can perform any of the above calculations on a calculator.

DATA

Can interpret simple two column table of numbers or data.

Can collect and record simple data in the form of a table such as numbers of children, numbers of TV's and use it to create simple bar graphs and pictograms using direct scales ie. one person equals one unit. Can interpret and analyse simple pie charts, bar graphs, pictograms and tables of the kind found on household bills, in comparative terms such as most, least, more than or less than.

LEVEL 2

MEASUREMENT

Can read and interpret the detailed calibrations such as mm, ml, g on a range of measuring instruments especially those relevant to work situations.

Can apply prefixes such as centi, milli, kilo to the base units of measurement such as metre or litre in such a way as to show understandings of their meaning.

Can perform calculations involving:

- conversions within the metric system such as metres to mm, litres to ml (not necessarily in decimal form);
- standard arithmetic operations;

in order to compare sizes, measured in different units and to calculate quantities for purchasing, supplying, filling or catering.

SPACE

Can follow instructions involving words and diagrams to create a three dimensional object from a flat plan or pre-cut net. This could include a 3D geometric shape in paper or metal, an origami figure or a piece of pre-fabricated office equipment or stationery.

Can name or describe three dimensional objects in terms of basic shapes and attributes such as flat, curved, cubic or triangular.

Can give or follow directions to get from one location to another using the language of direction and angles including North, South, East, West, 1/2 turn, 1/4 turn, 180 degree turns, 90 degree turns:

- within a yard, room or building; and
- from one suburb to another, making use of a street directory.

NUMBER

Demonstrate knowledge and understanding of place value in whole and decimal numbers by:

- comparing data and measurements;
- devising and using "in the head" methods for addition , subtraction and multiplication especially for quick money calculations.

Can recall addition and multiplication facts for single digit numbers in order to:

- perform standard calculations and rounded estimations for addition, subtraction, multiplication on whole numbers (particularly in the context of money and measurement);
- perform standard division operations when dividing by a single digit number and rounded estimation techniques for "long" division.

Can use a calculator for the above.

Can recognise the arithmetic in a relevant real world problem to which arithmetical operations apply, and find possible solutions using combinations of the above and check for feasibility of the solutions by referring back to the initial problem.

DATA

Can interpret complex tables and lists such as timetables, dosage charts, repayment tables or indexes.

Can collect and record statistical data in the form of a table. Use this data to plot statistical graphs including bar and line graphs using scales which count in 1's, 2's, 5's and 10's and appropriately marked axes.

Can analyse and interpret statistical graphs and tables relevant to political and social issues and use them to identify trends and make predictions.

Can determine the three different types of average: mean, median, and mode, for a collection of single values such as age or height of the group (using a calculator where appropriate) and interpret the use of the word "average" in a range of social and political contexts.

ALGEBRA

Can use oral or written expressions to describe and summarise spatial and numerical patterns.

Can find the unknown quantity in a worded 'problem solving' situation involving one step arithmetic operations using informal methods.

LEVEL 3

MEASUREMENT

Can use a protractor to measure and construct angles.

Can demonstrate an understanding of the concepts and appropriate units of :

- area by estimation and counting squares;
- simple rates such as speed and density by calculations based on empirical measurements;
- perimeter and circumference by estimation and measurement.

Can demonstrate an understanding of the formulae for area of a rectangle, and volume of a cuboid by using diagrams or by modelling with square tiles, cubes, MAB blocks, etc.

Can calculate areas of rectangles, volumes of cubes and cuboids, circumference of a circle using appropriate formulae.

Can, when given appropriate formula, calculate possible solutions and check their reality against the original situation using estimation and visualisation.

SPACE

Can use a set square to draw right angles, parallel and perpendicular lines.

Can demonstrate an understanding of the properties and relationships between angles and intersecting and parallel lines, triangles (including Pythagoras' Theorem), quadrilaterals and circles by:

- demonstration;
- explaining by example; or
- using the relationships in mathematical problem solving situations

Can produce, interpret and compare simple scale drawings and maps with scales such as 1 cm = 1 m.

Can interpret and use the conventions of plans and drawings, including 2D representations of 3D objects.

NUMBER

Can:

- use the standard operations +, - x and ÷ on numbers including fractions, decimals and percentages;
- perform these calculations with a calculator;
- estimate possible solutions to above calculations using rounding, approximation, and the idea of upper and lower bounds.

Can recognise the arithmetic in a relevant real world problem to which standard arithmetical operations apply, find a number of possible solutions using combinations of the above, check for the reasonableness of these solutions against initial estimations, and interpret the feasibility of the solutions by referring back to the initial problem.

Can use the concepts and language associated with ratio:

- to interpret and compare statements such as one in ten, a ratio of one to ten, 10% of the population, or statements of probability and odds used in gambling;
- to interpret and describe scales for diagrams, models or graphs.

Can interpret and perform calculations using standard formulae expressed in index notation with whole number indices, such as those for areas and volume, or financial calculations, with or without a calculator.

DATA

Can represent data in the form of a pie chart, after calculating percentages and angles. This data can either be collected first hand or found from other sources such as banks or the media.

Can represent statistical information, relevant to political, social and financial issues, in the form of line graph or histogram, having determined appropriate scales and axes (more complex than counting in 1's, 2's, 5's and 10's).

ALGEBRA

Can analyse, make a generalisation verbally and write an algebraic rule or formula to express this generalisation for:

- number patterns involving one or two arithmetic steps;
- real life situations which require repeated calculations such as working out costing, or conversions from one unit to another.

Can substitute particular values into algebraic rules or formulae as above, perform the resulting calculations, and interpret the results in the original context.

Can solve equations relating to an unknown quantity using a range of techniques, including: guess, check and improve; same thing to both sides; or backtracking. (Equations should include only one or two arithmetic steps at this level.)

Can show an understanding of graphs by:

- analysing those which model the relationship between real phenomena, such as travel graphs, and interpret them either orally or in writing;
- sketching rough graphs from a relationship described in words.

Can create tables and plot graphs relating two variables, given experimental results or data, and use the graphs to predict outcomes using interpolation and extrapolation.

LEVEL 4

MEASUREMENT

Can use the appropriate formula to find surface area and volume of:

- cubes and cuboids;
- regular prisms and cylinders;
- spheres; and
- complex figures which are a combination of any of these.

Can, when given a real world problem involving aspects of the above, analyse the problem, model the situation by sketching diagrams, select appropriate formulae, calculate possible solutions, and evaluate the feasibility of those solutions by referring back to the original situation.

Can demonstrate an understanding of accuracy and errors in measurement by calculating upper and lower bound solutions to the above problems.

Can use the property of right angled triangles known as Pythagoras' Theorem in order to calculate lengths in problem solving situations described in words.

SPACE

Can demonstrate an understanding of the trigonometric ratios, sine, cosine and tangent for a given angle in a right angle triangle:

- by calculating the ratio after measurement of an accurately constructed triangle; and
- using the ratios found accurately on a calculator in problem solving situations to find unknown lengths.

Can produce and interpret scale drawings and maps with complex scales, and use them to estimate sizes and distances in the real situations.

Can use at least one angle measuring instrument such as a direction finding compass, or clinometer in conjunction with tape measures or trundle wheels to make an accurate scale drawing of a real outdoor situation involving lengths and angles, and use the drawing to determine lengths and angles not previously measured.

Can use compass and ruler to construct some simple figures such as triangles to given measurements, or perpendicularly bisected lines or angles.

NUMBER

Can:

- read and interpret very large and very small numbers when expressed in scientific notation, or as a calculator readout;
- use the laws of directed numbers to plus, minus, multiply and divide, positive and negative numbers; and
- use the index laws for multiplication and division to perform calculations when numbers are expressed in scientific form, particularly when calculating approximate solutions for real world problems involving very large numbers.

Can recognise the arithmetic in a relevant real world problem to which large number calculation techniques apply, such as those involving populations, production/consumption of energy or food, probability of winning lotteries and other social issues; find a number of possible solutions using combinations of the above, check for the reasonableness of these solutions against initial estimations, and interpret the feasibility of the solutions by referring back to the initial problem.

DATA

Can collect and record statistical data in the form of a frequency table that requires grouping into class intervals. Use this data to plot appropriate statistical graphs including cumulative frequency curves and histograms, using standard graphing conventions to place axes, indicate scales and location of origin.

Can analyse and interpret statistical information, graphs and tables relevant to political and social issues using determined measures such as mode, median and percentiles.

ALGEBRA

Can recognise the potential for algebraic methods in problem solving situations which involve unknown quantities, and can formulate an algebraic equation to express the situation using standard algebraic conventions.

Can solve equations as above using a range of techniques including: guess, check and improve; same thing to both sides, backtracking and creating a graph; and interpret the solutions in the original context.

Can analyse, make a generalisation verbally and express this generalisation algebraically or graphically for:

- non-linear number patterns; and
- real or simulated situations such as exponential growth or decay, and direct or inverse variation.

Can obtain particular values from the algebraic rules, formulae or graphs as above, perform the resulting calculations, and interpret the results in the original context.